In the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Previously Presented) An ion generating system for generating an ion beam comprising: a vaporizer of solid feed material for producing vapor of the material, an ion source and extraction electrode within a vacuum housing, and a reactive gas cleaning system, the ion source comprising

an ionization chamber connected to a high voltage power supply and having an inlet for vapor of the material from the vaporizer, an energizeable ionizing system for ionizing the vapor within the ionization chamber and an extraction aperture that communicates with the vacuum housing, the vacuum housing evacuated by a vacuum pumping system,

the extraction electrode disposed in the vacuum housing outside of the ionization chamber, aligned with the extraction aperture of the ionization chamber and adapted to be maintained at a voltage below that of the ionization chamber to extract ions through the aperture from within the ionization chamber to form the ion beam,

surfaces of the ion generating system being susceptible to accumulating deposits of feed material or related contaminant during operation of the ion source,

and the reactive gas cleaning system operable when the ion source is de-energized to provide a flow of reactive gas into and through the ionization chamber and through the ion extraction aperture to react with and remove the deposits on at least some of the surfaces of the ion generating system.

2-69. (canceled)

70. (Previously Presented) The system of claim 1 in which the reactive gas cleaning system comprises a supplement reactive gas generator capable of disassociating a gaseous feed compound to provide reactive gas, the generator operable when the ion source is de-energized to provide a flow of reactive gas into and through the ionization chamber and through the ion extraction aperture to react with and remove the deposits on at least some of the surfaces of the

ion generating system.

71. (Previously Presented) The system of claim 70 constructed to produce the reactive cleaning gas flow by a generator that comprises a supplemental plasma chamber, the supplemental plasma chamber arranged to receive a gaseous feed compound capable of being disassociated by plasma within the plasma chamber to produce the flow of reactive cleaning gas through an outlet, and a conduit for transporting the reactive gas from the supplemental plasma chamber to the ionization chamber.

72. (Previously Presented) The system of claim 1 in which the source material to be ionized by the ion source comprises a molecule that is subject to producing a material that is condensable on surfaces of the ion generating system during ion source operation and the reactive gas is selected to be capable of reacting with the condensable material to form a volatilized reaction product.

73. (Previously Presented) The system of claim 1 in which the ion source is a low temperature ion source, the energizeable device of the ion source being constructed to produce a focused electron beam for electron-impact ionization or constructed to operate as an RF field ion source.

74. (Previously Presented) The system of claim 1 having a vaporizer constructed to vaporize a solid borohydride source material and supply borohydride vapor to the ionization chamber for ionization.

75. (Currently Amended) The system of claim 74 in which the borohydride material is decaborane, ~~B10H14~~ $\underline{B_{10}H_{14}}$, and the reactive gas cleaning system is adapted to remove condensed decomposition products of decaborane from the surfaces.

76. (Currently Amended) The system of claim 75 in which the borohydride material is octa-decaborane, $B_{18}H_{22}$ ~~B18H22~~, and the reactive gas cleaning system is adapted to remove condensed decomposition products of octa-decaborane from the surfaces.

77. (Previously Presented) The system of claim 1 in which the reactive gas cleaning system

comprises a supplemental reactive gas generator constructed to disassociate a gaseous compound to atomic fluorine.

78. (Previously Presented) The system of claim 1 in which the reactive gas cleaning system comprises a supplemental reactive gas generator constructed and arranged to share a service facility with the ion source.

79. (Previously Presented) The system of claim 1 combined with a system to direct the extracted ion beam through a mass analyzer, in which the reactive gas cleaning system is a supplemental reactive gas generator constructed and arranged to share a service facility with the mass analyzer.

80. (Previously Presented) The system of claim 1 in which the ionization chamber is supported within a vacuum housing via an insulative bushing that enables the ion source, when energized during its operation, to be maintained at a voltage potential substantially different from that of the vacuum housing, and the reactive gas cleaning system is disposed to be maintained at the potential of the ion source, and communicates with the ionization chamber through the insulative bushing.

81. (Previously Presented) The system of claim 80 in which the reactive gas cleaning system comprises a supplemental reactive gas generator capable of disassociating a gaseous feed compound to provide reactive gas, the generator operable when the ion source is de-energized to provide a flow of reactive gas into and through the ionization chamber and through the ion extraction aperture to react with and remove the deposits on at least some of the surfaces of the ion generating system.

82. (Previously Presented) The system of claim 81 constructed to produce the reactive gas flow by a generator that comprises a supplemental plasma chamber, the supplemental plasma charged to receive a gaseous feed compound capable of being disassociated by plasma within the plasma chamber to produce flow of reactive cleaning gas through an outlet, and a conduit for transporting the reactive gas from the supplemental plasma chamber to the ionization chamber.

83. (Previously Presented) The system of claim 1 in which the ionization chamber is supported within the vacuum housing via an insulative bushing that enables the ion source, during operation, to be maintained at a voltage potential substantially different from that of the vacuum housing, and the reactive gas cleaning system is disposed to be maintained at the potential of the vacuum housing, an communicates with the ionization chamber through the wall of the housing, thence via a voltage break separate from the insulative bushing to the ionization chamber.

84. (Previously Presented) The system of claim 83 in which the reactive gas cleaning system comprises a supplemental reactive gas generator capable of disassociating a gaseous feed compound to provide reactive gas, the generator operable when the ion source is de-energized to provide a flow of reactive gas into and through the ionization chamber and through the ion extraction aperture to react with and remove the deposits on at least some of the surfaces of the ion generating system.

85. (Previously Presented) The system of claim 84 constructed to produce the reactive gas flow by a generator that comprises a supplemental plasma chamber, the supplemental plasma chamber arranged to receive a gaseous feed compound capable of being disassociated by plasma within the plasma chamber in produce the flow of reactive cleaning gas through an outlet, and a conduit for transporting the reactive gas from the supplemental plasma chamber to the ionization chamber.

86. (Currently Amended) The system of claim 1 in combination with a monitoring system adapted to monitor ~~at least some aspect of~~ the progress of cleaning action of the reactive gas on the surfaces.

87. (Previously Presented) The system of claim 86 in which the monitoring system comprises an end-point detection system adapted to at least assist in detecting substantial completion of reaction of the reactive gas with contamination on the surfaces.

88. (Previously Presented) The system of claim 87 in which the end point detection system comprises analysis system for the chemical makeup of gas that has been exposed to the surfaces

during operation of the nerve gas cleaning system.

89. (Previously Presented) The system of claim 86 in which the monitoring system comprises a temperature detector arranged to detect progress or termination of an exothermic reaction of the reactive gas with contamination the surfaces.

90. (Currently Amended) The system of claim 1 in which the ion source includes a component within or in communication with the ionization chamber that is susceptible to harm by the reactive gas, and means are provided ~~to protect~~ for protecting the component from the reactive gas.

91. (Currently Amended) The system of claim 90 in which ~~the~~ said protecting means comprises a conduit for producing a flow of inert gas~~, such as argon,~~ past the component susceptible to harm.

92. (Previously Presented) The system of claim 1 in which the reactive gas is a halogen and surfaces of the ion generating system from which deposits are to be removed by the reactive gas are comprised of material resistant to attack by the halogen.

93. (Previously Presented) The system of claim 92 in which the ion source is a low temperature ion source and surfaces of the ion generating system comprising the ion source or an exposed portion of the extraction electrode closest to the ion source, from which deposits are to be removed, are comprised of aluminum or an aluminum-based material that is resistant to attack by the halogen.

94. (Previously Presented) The system of claim 1 in which the ion source is disposed within a vacuum housing associated with a pumping system, the pumping system comprising a high vacuum pump capable of producing high vacuum and a backing pump capable of producing rough vacuum, the high vacuum pump operable during operation of the ion source, and being capable of being isolated from the vacuum housing during operation of the reactive gas cleaning system, the backing pump operable during operation of the reactive gas cleaning sub-system to remove volatized reaction products.

95. (Previously Presented) The system of claim 1 in which the extraction electrode is associated with an electrical heater, the heater adapted, during ion extraction, to maintain the extraction electrode at elevated temperature above the condensation temperature of vapors derived from solid feed material being ionized.

96. (Previously Presented) A method of producing an ion beam employing the system of claim 1, including the steps of operating the ion source and thereafter discontinuing operation of the ion source and subjecting the surfaces to cleaning by flow into the ionization chamber of reactive gas such as atomic fluorine.

97. (Previously Presented) The mea of claim 96 including employing the ion source to produce an ion beam that is implanted into a target.

98. (Previously Presented) The method of claim 97 conducted to vaporize a solid borohydride source material and supply borohydride vapor to the ionization chamber for ionization.

99. (Currently Amended) The method of claim 98 in which the borohydride material is decaborane, ~~B10H14~~ $B_{10}H_{14}$, and the reactive gas cleaning system is employed to remove condensed decomposition products of decaborane from the surfaces.

100. (Currently Amended) The method of claim 98 in which the borohydride material is octa-decaborane, ~~B18H22~~ $B_{18}H_{22}$, and the reactive gas cleaning system is employed to remove condensed decomposition products of octa-decaborane from the surfaces.

101. (Currently Amended) The method of claim 97 employed to implant ions selected from the group consisting of (arsenic-containing compounds ~~(such as arsine)~~ , arsine, element arsenic, phosphorus-containing compounds , ~~(such as phosphine),~~ phosphine, elemental phosphorus, antimony-containing compounds , ~~(such as~~ trimethylantimony , ~~and~~ antimony pentafluoride~~),~~ silicon compounds, and ~~or~~ germanium compounds.

102. (Previously Presented) An ion generating system for generating a ion beam comprising: a source of feed material in gaseous or vaporized form, an ion source and an extraction electrode within a vacuum housing, and a reactive gas cleaning system, the ion source comprising:

an ionization chamber connected to a high voltage power supply and having an inlet for gaseous or vaporized feed material,

an energizeable ionizing system for ionizing the gaseous or vaporized feed material with the ionization chamber,

and an extraction aperture that communicates with the vacuum housing, the vacuum housing evacuated by a vacuum pumping system,

the extraction electrode disposed in the vacuum housing outside of the ionization chamber, aligned with the extraction aperture of the ionization chamber, and adapted to be maintained at a voltage below that of the ionization chamber to extract ions through the aperture from within the ionization chamber to form the ion beam,

surfaces of the ion generating system being susceptible to accumulating deposits of feed material or related con during operation of the ion source, and

the reactive gas cleaning system comprising a supplemental reactive cleaning gas generator capable of disassociating a gaseous feed compound to provide reactive gas, the generator operable when the ion source is de-energized to provide a flow of reactive gas into and through the ionization chamber and through the ion extraction aperture to react with and remove the deposits on at least some of the surfaces of the ion generating system.

103. (Previously Presented) The system of claim 102 constructed to produce the reactive cleaning gas flow by a generator that comprises a supplemental plasma chamber, the supplemental plasma chamber arranged to receive a gaseous feed compound capable of being disassociated by plasma within the plasma chamber to produce the flow of reactive cleaning gas through an outlet, and a conduit for transporting the reactive gas from the supplemental plasma chamber to the ionization chamber.

104. (Previously Presented) The system of claim 102 in which the source material to be ionized by the ion source comprises a molecule that is subject to producing a material that is condensable on surfaces of the ion generating system during ion source operation and the reactive gas is selected to be capable of reacting with the condensable material to form a volatilized reaction product.

105. (Previously Presented) The system of claim 102 in which the ion source is a low temperature ion source, the energizeable device of the ion source being constructed to produce a focused electron beam for electron-impact ionization or constructed to operate as an RF field ion source.

106. (Previously Presented) The system of claim 102 having a vaporizer constructed to vaporize a solid borohydride source material and supply borohydride vapor to the ionization chamber for ionization.

107. (Currently Amended) The system of claim 106 in which the borohydride material is decaborane, ~~B10H14~~ $\underline{B_{10}H_{14}}$ and the reactive gas cleaning system is adapted to remove condensed decomposition products of decaborane from the surfaces.

108. (Currently Amended) The system of claim 106 in which the borohydride material is octa-decaborane, ~~B18H22~~ $\underline{B_{18}H_{22}}$, and the reactive gas cleaning system is adapted to remove condensed decomposition products of octa-decaborane from the surfaces.

109. (Previously Presented) The system of claim 102 in which the reactive gas cleaning system comprises a supplemental reactive gas generator constructed to disassociate a gaseous compound to atomic fluorine.

110. (Previously Presented) The system of claim 102 in which the reactive gas cleaning system comprises a supplemental reactive gas generator constructed an arranged to share a service facility with the ion source.

111. (Previously Presented) The system of claim 102 combined with a system to direct the extracted ion beam tough a mass analyzer, in which the reactive gas clearing system is a supplemental reactive gas generator constructed and arranged to share a service facility with the as analyzer.

112. (Previously Presented) The system of claim 102 in which the ionization chamber is supported within a vacuum housing via an insulative bushing the enables the ion source, when energized during its operation, to be maintained at a voltage potential substantially different from that of the vacuum housing, and the reactive gas cleaning system is disposed to be maintained at the potential of the ion source, and communicates with the ionization chamber through the insulative bushing.

113. (Previously Presented) The system of claim 102 in which the ionization chamber is supported within the vacuum housing via a insulative bushing that enables the ion source, during operation, to be maintained at a voltage potential substantially different from that of the vacuum housing, and the reactive gas cleaning system is disposed to be maintained at the potential of the vacuum housing, and communicates with the ionization chamber through the wall of the housing, thence via a voltage break separate from the insulative bushing to the ionization chamber.

114. (Previously Presented) The system of claim 102 in combination with a monitoring system adapted to monitor at least some aspect of the progress of cleaning action of the reactive gas on the surfaces.

115. (Previously Presented) The system of claim 114 in which the monitoring system comprises an end-point detection system adapted to at least assist in detecting substantial completion of reaction of the reactive gas with combination on the surfaces.

116. (Previously Presented) The system of claim 115 in which the end point detection system comprises an analysis system for chemical makeup of gas that has been exposed to the surfaces during operation of the reactive gas cleaning system.

117. (Previously Presented) The system of claim 114 in which the monitoring system comprises a temperature detector arranged to detect progress or termination of an exothermic reaction of the reactive gas with communication on the surfaces.

118. (Previously Presented) The system of claim 102 in which the ion source includes a component within or in communication with the ionization chamber that is susceptible to harm by the reactive gas, and means are provided to protect the component from the reactive gas.

119. (Previously Presented) The system of claim 118 in which the means comprises a conduit for producing a flow of inert gas, such as argon, past the component susceptible to harm.

120. (Previously Presented) The system of claim 102 in which the reactive gas is a halogen and surfaces of the ion generating system from which deposits are to be removed by the reactive gas are comprised of material resistant to attack by the halogen.

121. (Previously Presented) The system of claim 120 in which the ion source is a low temperature ion source and surfaces of the ion generating system comprising the ion source or an exposed portion of the extraction electrode closest to the ion source, from which deposits are to be removed, are comprised of aluminum or an aluminum-based material that is resistant to attack by the halogen.

122. (Previously Presented) The system of claim 102 in which the ion source is disposed within a vacuum housing associated with a pumping system the pumping system comprising a high vacuum pump capable of producing high vacuum and a backing pump capable of producing rough vacuum, the high vacuum pump operable during operation of the ion source, and being capable of being isolated from the vacuum housing during operation of the reactive gas cleaning system, the backing pump operable during operation of the reactive gas cleaning system to remove volatilized reaction products.

123. (Previously Presented) The system of claim 102 in which the extraction electrode is

associated with an electrical heater, the heater adapted during ion extraction, to maintain the extraction electrode at elevated temperature above the condensation temperature of gaseous or vaporous material leaving the ion source.

124. (Previously Presented) A method of producing an ion ea employing the system of claim 102, including the steps of operating the ion source an thereafter discontinuing operation of the ion source and subjecting the surfaces to cleaning by flow into the ionization chamber of reactive gas.

125. (Previously Presented) The method of claim 124 including employing the ion source to produce an ion beam that is implanted into a target.

126. (Previously Presented) The method of claim 125 conducted to vaporize a solid borohydride source material and supply borohydride vapor to the ionization chamber for ionization.

127. (Currently Amended) The method of claim 126 in which the borohydride material is decaborane, ~~B10H14~~ $B_{10}H_{14}$, and the reactive gas cleaning system is employed to remove condensed decomposition products of decaborane from the surfaces.

128. (Currently Amended) The method of claim 126 in which the borohydride material is octa-decaborane, ~~B18H22~~ $B_{18}H_{22}$, and the reactive gas cleaning system is adapted to remove condensed decomposition products of octa-decaborane from the surfaces.

129. (Currently Amended) The method of claim 125 employed to implant ions selected from the group consisting of arsenic-containing compounds ~~(such as arsine)~~ , arsine, elemental arsenic, phosphorus-containing compounds ~~(such as phosphine)~~ , phosphine , elemental phosphorus, antimony-containing compounds ~~(such as~~ trimethylantimony , an antimony pentafluoride~~)~~, silicon compounds ~~or~~ and germanium compounds.

130.(Previously Presented) An ion implantation system having an ion source and an extraction electrode for extracting ions from the ion source, in which the extraction electrode is associated

with an electrical heater, the heater adapted, during ion extraction, to maintain the extraction electrode at elevated temperature above the condensation temperature of gaseous or vaporous material leaving the ion source.

131. (Previously Presented) The system of claim 130 in which the electrode comprises aluminum.

132. (Previously Presented) The system of claim 130 in which the electrode comprises of molybdenum.

133. (Previously Presented) The system of claim 130 in which ft electrode is heated by radiative heaters.

134. (Previously Presented) The system of claim 130 in which the electrode is treated by resistive heaters.

135. (Previously Presented) The system of claim 130 in which the temperature of the electrode is controlled to a desired temperature.

136. (Previously Presented) The system of claim 135 in which the temperature is between 150 C and 250 C.

137.(Previously Presented) A method of producing an ion beam employing the system of claim 130, comprising electrically heating the extraction electrode while extracting ions from the ion source.

138. (Previously Presented) The method of claim 137, including the steps of operating the ion source and thereafter discontinuing operation of the ion source and subjecting the extraction electrode surface to cleaning by flow of reactive gas.